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[Name of Document]            Description  
[Title of the Invention]        POLISHING PAD, PREPARATION  
5 METHOD THEREOF, AND POLISHING METHOD USING THE SAME  
[CLAIMS]        [Claim 1]

10        A polishing pad used in polishing a work as it is bonded  
to a polishing table, comprising a fiber mainly of a polyester  
fiber exposed on the polishing surface and the maximum exposure  
length of the fiber is 0.1 mm or less.

[Claim 2]

      The polishing pad according to Claim 1, wherein chopped  
polyester fiber is dispersed in an organic resin matrix.

[Claim 3]

15        The polishing pad according to Claim 1 or 2, wherein  
multiple sheets of a polyester nonwoven fabric are laminated  
in an organic resin matrix.

[Claim 4]

20        A method of producing a polishing pad used for flattening  
a polishing surface of a working material as it is bonded to  
a polishing table, comprising a step of mixing an organic fiber  
with a resin, a step of tabletizing or pelletizing the mixture  
of the organic fiber and the resin, and a step of molding the  
tablets or pellets into plate shape by extrusion molding or  
25 injection molding.

[Claim 5]

      A method of producing the polishing pad according to Claim

1 used for flattening a polishing surface of a working material  
as it is bonded to a polishing table, comprising a step of preparing  
a resin-impregnated sheet-shaped fiber base material containing  
a polyester fiber mainly as the fiber and a step of laminating  
5 the sheets of the sheet-shaped fiber base material by molding  
under heat and pressure.

[Claim 6]

A polishing method of polishing a substrate, comprising  
pressing a particular substrate to the organic fiber-exposed  
10 face of the polishing pad according to any one of Claims 1 to  
3, while supplying a polishing slurry between the polishing  
surface and the pad, and sliding the substrate and the polishing  
pad relatively to each other.

[Detailed Description of the Invention]

15 [0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a precision polishing  
pad for use in chemical mechanical polishing (CMP), for example  
in production of semiconductor elements and hard disks, and a  
20 polishing method using the same.

[0002]

[Prior Art]

In the current trend toward increase in packaging density  
of ultra-large-scale integrated circuit, various  
25 microfabrication technologies are now under research and  
development. The design rule is already in the sub-half micron  
order. One of the technologies under development for satisfying

the strict requirements in microfabrication is CMP (chemical mechanical polishing) technology. The technology is effective in flattening the layer to be exposed to light completely, alleviating the load on exposure technology. Thus, it is a method essential, for example, for smoothening films such as interlayer insulation film and BPSG film and performing shallow trench separation.

[0003]

The polishing pad commonly used then is a polishing pad of a foam or non-foam organic resin (see, for example, Patent Document 1). There is a problem of polishing speed and damage (scratch) on the polishing surface caused by polishing particle and polishing waste. It is very effective to reduce the rigidity of polishing pad for reduction of scratch when a common polishing pad of a foamed or non-foamed organic resin is used, but it also results in decrease of the polishing speed. It may further lead to unfavorable dishing of trench areas. It was difficult to satisfy these properties at the same time.

[0004]

[Patent Document 1] Japanese Patent Application National Publication (Laid-Open) No. 8-511210 (Claims and Background of the invention)

[0005]

[Problems to be Solved by the Invention]

The present invention provides a polishing pad that allows efficient flattening and metal wiring, and suppression of the scratches on polishing surface in the CMP technology used for

flattening of interlayer insulating film, BPSG film, insulation film for shallow trench isolation and forming of metal wiring and the like in the semiconductor element-manufacturing process, and a polishing method using the same.

5 [0006]

[Means for Solving the Problems]

The present invention was made after intensive studies on the structure of polishing pad for improvement in flatness of semiconductor devices for easier high-definition  
10 microfabrication.

Accordingly, a first aspect of the present invention relates to a polishing pad used in polishing a work as it is bonded to a polishing table, comprising a fiber mainly of a polyester fiber exposed on the polishing surface and the maximum  
15 exposure length of the fiber is 0.1 mm or less.

A second aspect of the present invention relates to a method of producing a polishing pad used for flattening a surface of a working material as it is bonded to a polishing table, comprising a step of mixing an organic fiber with a resin, a step of  
20 pelletizing the mixture of the organic fiber and the resin, and a step of molding the pellets into plate shape by extrusion molding or injection molding.

A third aspect of the present invention relates to a method of producing a polishing pad used for flattening a polishing  
25 surface of a working material as it is bonded to a polishing table, comprising a step of preparing a resin-impregnated sheet-shaped fiber base material containing a polyester fiber

mainly as the fiber and a step of laminating multiple sheets of the sheet-shaped fiber base material by molding under heat and pressure.

A fourth aspect of the present invention relates to a polishing method of polishing a substrate, comprising pressing a particular substrate to the organic fiber-exposed face of the polishing pad, while supplying a polishing slurry between the polishing surface and the pad, and sliding the substrate and the polishing pad relatively to each other.

[0007]

The maximum exposure length of the organic fiber exposed on the polishing surface is the maximum value of the length of the exposed region of the fibers fixed on the polishing pad surface substantially. Practically, it is determined by observing the fibers at about five points or more on the pad for example, under a SEM (scanning electron microscope).

[0008]

[Mode for Carrying out the Invention]

The structure of the polishing pad according to the present invention is not particularly limited, if it is a polishing pad characterized in that the fiber is exposed on polishing surface-sided surface at least during use and the maximum exposure length of the fiber is 0.1 mm or less.

The maximum exposure length is not particularly limited, if it is 0.1 mm or less, but preferably 0.001 to 0.05 mm, more preferably 0.001 to 0.025 mm. Increase in the maximum exposure length leads to deterioration in flatness, which in turn leads

to decrease in polishing speed.

[0009]

The polishing pad according to the present invention has a polyester fiber as its principal component. It is because  
5 it is possible to reduce the maximum exposure length easily by dressing treatment in the step of exposing the fiber of polishing pad, because the polyester fiber has a lower shearing strength than other hard fibers. Alternatively when a hard fiber such as another aramide fiber or a polyimide fiber is used, the maximum  
10 exposure length should be controlled by reduction in size of the whetstone particles used, as will be described below. The surface roughness of the pad depends on the diameter of the whetstone particles used then, and thus, the diameter of the particles influences on the irregularity of the pad surface and  
15 thus on polishing speed. On the contrary, when a polyester fiber is used, the exposure length hardly varies, no matter which whetstone is used among those different in particle diameter. Thus, it becomes possible to adjust the surface roughness of the pad freely while keeping the fiber length to a constant value.

20 One of the hard fibers described above may be used as mixed with the polyester fiber. The content of the polyester fiber then is preferably 40 to 100 wt%, more preferably 70 to 100 wt%, and still more preferably 80 to 100 wt%. Increase in the content of the polyester fiber may lead to decrease in the thickness  
25 of the fiber-exposed layer, while increase in the amount of hard fiber to increase in the thickness of the layer and deterioration in the flatness .

[0010]

The polishing pad is produced, for example, by dispersing a fiber containing a polyester fiber as the principal component in a matrix organic resin and molding the resulting resin, or  
5 laminating multiple sheets of a prepreg, a woven or nonwoven fabric of fiber impregnated with a resin, but the production method is not limited thereto.

Any one of common thermosetting and thermoplastic resins may be used without restriction as the matrix resin holding a  
10 fiber in the polishing pad according to the present invention. Examples of the thermosetting resins include epoxy resins, phenol resins, unsaturated polyester resins, acrylic resins, polyurethane and the like. Examples of the thermoplastic resins include polycarbonate, polymethyl methacrylate, AS  
15 (acrylonitrile-styrene copolymers), ABS (acrylonitrile-butadiene rubber-styrene copolymers), polyethylene, polypropylene, polybutene, 4-methyl-pentene-1, ethylene-propylene copolymer, ethylene vinyl acetate copolymers, polyester, polyamide, polyamide-imide, polyacetal  
20 and the like. These resins may be used alone or as a mixture of two or more.

[0011]

The diameter of the fiber is preferably 1 mm or less, more preferably 200  $\mu\text{m}$  or less, preferably 1 to 200  $\mu\text{m}$ , more preferably  
25 5 to 150  $\mu\text{m}$ . An excessively large diameter may lead to an excessively high mechanical strength, occasionally causing polishing scratch and inadequate dressing. Alternatively, an

excessively smaller diameter may lead to deterioration in handling efficiency and also in pad durability because of insufficient strength.

The length of the fiber is not particularly limited, but, if the polishing pad contains chopped fibers dispersed in a resin, the length thereof is preferably 10 mm or less, more preferably 5 mm or less, and still more preferably, 0.1 to 3 mm. An excessively shorter length may lead to lack of maintaining effectively the exposed from the pad when the pad surface is mechanically roughened, while an excessively longer length may make molding of a mixture of a resin and the fiber difficult because of the increase in viscosity of the mixture. It is possible to use the short fibers chopped to a particular length, or to use a mixture of several short fibers different in length. In addition, the fiber surface may be previously roughened mechanically or modified chemically, for example, with a coupling agent for improvement in compatibility with the resin. Bundles of chopped short fibers adhered to each other with an extremely small amount of resin may be used for convenience in handling. However, the resin for adhesion is added in such an amount that the short fiber is easily dispersed in the matrix resin by the heat or the shearing force applied during agitation with the matrix resin.

[0012]

When a nonwoven fabric is used, a sheet produced with binding fibers of 1 mm or more in length similarly as described above by the adhesive force of the fiber itself or with an



additional adhesive added may be used as the nonwoven fabric. The adhesive may be, for example, an epoxy resin adhesive such as water-soluble epoxy resin binder, or the like. When an adhesive is used, the amount is not particularly limited, but is preferably 3 to 20 parts by weight, more preferably 5 to 15 parts by weight, with respect to 100 parts by weight of the fiber.

[0013]

A woven fabric of continuous filament may also be used. In such a case, the weaving pattern of the fabric is not particularly limited. The basis weight of the nonwoven and woven fabrics above is preferably 36 to 100 g/m<sup>2</sup>, more preferably 55 to 72 g/m<sup>2</sup>.

The content of the organic fiber is not particularly limited, but, is preferably 1 to 50 wt% in the entire pad, more preferably 2 to 20 wt%, when a chopped fiber is used entirely in the pad. On the other hand, the content thereof in woven fabric or nonwoven fabric is preferably 50 wt% or more, more preferably 60 to 80 wt%.

[0014]

The method of producing the resin composition for forming the pad-shaped molding according to the present invention is not particularly limited, and any one of known methods may be used. Thus if a chopped fiber is to be dispersed in a matrix resin as it is, matrix-forming resin components are blended (dry blended) uniformly, for example, in a Henschel Mixer, supermixer, tumble mixer, ribbon blender, or the like, and melt blended, for example, in a single screw extruder, biaxial extruder,

Banbury mixer, or the like. Then, the fiber is added and melt-blended, and the mixture is then cooled and tabletized or pelletized. The composition should be dehydrated thoroughly by drying, if water is used for cooling. The final sheet-shaped molding is prepared by extruding the tablets or pellets of the thermoplastic resin composition through a dice from an injection molding machine and rolling the resulting sheet. The molding may also be prepared in a mold by extruding the resin composition therein under pressure and heat.

[0015]

When the matrix resin is a liquid thermosetting resin, it is possible to prepare a polishing pad, by dispersing a predetermined amount of chopped fiber in the liquid thermosetting resin, extruding the dispersion mixture into a mold or the like, removing air bubbles therein under reduced pressure, and then heat-curing the mixture. The molding in a mold under pressure and heat as described above may also be produced.

[0016]

In another embodiment of the production method according to the present invention,

it may be produced by preparing a resin-impregnated sheet-shaped fiber base material mainly containing a polyester fiber as the fiber and laminating the sheets of the sheet-shaped fiber base material under heat and pressure.

For example if a woven or nonwoven fabric is used, it is possible to obtain a polishing pad by using the fibrous resin-impregnated sheet-shaped base materials, or

alternatively a fibrous resin-impregnated sheet-shaped base material and a fibrous non-resin-impregnated sheet-shaped base material and integrating these base materials by high-temperature high-pressure molding. It is also preferable then to make some organic fibers exposed on the surface by placing a fibrous non-resin-impregnated sheet-shaped base material at least on one surface.

[0017]

The fibrous resin-impregnated sheet-shaped base material is produced by impregnating a fibrous non-resin-impregnated sheet-shaped base material with a resin, and it is normally called a prepreg. The prepreg can be produced by preparing a varnish by dissolving the resin components in an organic solvent, impregnating a fibrous non-resin-impregnated sheet-shaped base material with the varnish, and heating and drying the resulting base material. The solvent for use is not particularly limited, if it dissolves the resin composition uniformly. Examples thereof include ketones such as methylethylketone, methylisobutylketone, and acetone; lower alcohols such as ethyl alcohol, propyl alcohol, and isopropyl alcohol; amides such as dimethylformamide and formamide; and the like, and these solvents may be used in combination. The content of the fiber in the fibrous resin-impregnated sheet-shaped base material is preferably 60 to 140 parts by weight, more preferably 90 to 120 parts, with respect to 100 parts by weight of the total of resin and adhesive.

[0018]

The ratio of the fibrous non-resin-impregnated sheet-shaped base material in polishing pad is decided properly, taking into consideration the fiber content in the polishing pad, in particular the content of the organic fiber on the surface facing the work material. By the method, it is not necessary to change the resin content during production of the prepreg, for alteration of the fiber content in the polishing pad, but the fiber content can be modified only by changing the ratio of the fibrous non-resin-impregnated sheet-shaped base material used.

[0019]

The heating temperature during the high-temperature high-pressure molding is generally 150 to 200°C, and the pressure is 50 to 500 kPa. These parameters may be changed suitably according to the kind and the content of the thermosetting resin used.

[0020]

The thickness of the entire polishing pad is preferably 0.1 to 5 mm, more preferably 0.5 to 2 mm. The polishing pad is then processed into a final product having a size suitable for the polishing table of a particular polishing machine. For example, it may be processed into a product, by cutting it into circular shape. Concentric, lattice-shaped or other grooves may be formed on the polishing surface of the pad, for example, with a NC lathe.

[0021]

In the invention, one of the methods for exposing the fiber

on the polishing pad surface is dressing treatment, a method of exposing the fiber by scraping off the pad surface by using a whetstone such as diamond powder. Other material such as wire brush, metal scraper, resin brush, or glass or ceramic plate  
5 may be used, instead of the whetstone.

[0022]

The condition of using the material should be decided carefully, for adjustment of the fiber exposure length. The maximum exposure fiber length depends largely on the rigidity  
10 of fiber, but use of a polyester fiber in the pad allows easy adjustment thereof to a smaller length.

In addition, grooves, channels for polishing slurry and polishing dust, may be formed as needed.

For connection of the polishing pad to the polishing table  
15 of polishing machine, an adhesive such as double-faced adhesive tape may be used on the face of the pad opposite to the polishing surface. Alternatively, it may be connected with a low-modulus subpad, for example, of foamed polyurethane.

[0023]

Hereinafter, the method of polishing a substrate by using the polishing pad according to the present invention will be described. The polishing substrate may be, for example, a semiconductor, i.e., a semiconductor substrate carrying circuit elements and a wiring pattern immediately after preparation,  
25 or a substrate having a silicon oxide or nitride film layer formed thereon.

Alternatively, it may be a substrate having a barrier film

formed over an interlayer insulation film formed by dry etching of viaholes and trenches, covering the openings and internal walls completely, or a substrate having all of the openings therein completely covered with a Cu film grown thereon.

5 [0024]

The CMP polishing slurry for use in the polishing method according to the present invention is not specified here, but an example thereof for insulation films is a polishing slurry prepared by dispersing a composition consisting of cerium oxide  
10 (ceria) or silicon oxide (silica) particles and a dispersant in a dispersion medium such as water and adding additives additionally thereto.

[0025]

On the other hand, examples of the polishing slurries to  
15 the metal such as Cu include polishing particles such as silica, alumina, ceria, titania, zirconia and germania, and polishing slurries containing an additive, an anticorrosive and an additional peroxide dispersed in water. Colloidal silica or alumina particles are particularly favorable as the polishing  
20 particle.

[0026]

The content of the polishing particles in the polishing slurry is preferably 0.1 to 20 wt%. The polishing particles may be prepared in any way, but the average diameter is preferably  
25 0.01 to 1.0  $\mu\text{m}$ . A polishing particle having an average diameter of less than 0.01  $\mu\text{m}$  leads to decrease in polishing speed, while that of more than 1.0  $\mu\text{m}$  causes an increased number of scratches.

[0027]

The polishing pad according to the present invention and the polishing method using the same are applicable not only to the films containing mainly a metals such as Cu, Ta, TaN or Al having an insulation layer with filled composite openings, but also to inorganic insulation films formed on a particular wiring board such as of silicon oxide film, glass, and silicon nitride, films mainly containing polysilicon, optical glasses such as photomask, lens and prism, inorganic conductive films such as of ITO, optical single crystals of glass or a crystalline material such as optical integrated circuit, optical switching element, end face of optical waveguide-optical fiber, and scintillator, solid state laser single crystals, sapphire substrates for blue laser LED, semiconductor single crystals of SiC, GaP, and GaAs, glass or aluminum substrates for magnetic disk, and magnetic heads, and the like.

[0028]

The polishing machine is not particularly limited, and, for example, a disk polishing machine or a linear polishing machine may be used. For example, common polishing machines having a holder for holding a work material and a polishing table for connection to a polishing pad (that is connected to a variable frequency motor) may be used. The polishing condition is not particularly limited, but is preferably optimized according to the work material. A polishing slurry is supplied continuously, for example, by a pump to the polishing pad during polishing. The feed rate is not limited, but the surface of the polishing

pad is preferably covered always with the polishing slurry. The pad and the exposed organic fiber degenerated by semiconductor substrate polishing are regenerated by dressing.

[0029]

- 5           The work material after polishing is preferably washed thoroughly with running water and dried after the water drops on the polishing surface are removed, for example, by using a spin dryer.

[0030]

- 10          [Example]

Hereinafter, the present invention will be described in detail with reference to Examples, but it should be understood that the present invention is not restricted by these Examples.

[0031]

- 15          Example 1

A nonwoven fabric having a basis weight of 70 g/m<sup>2</sup> ("EPM-4070TE", manufactured by Japan Vilene Co., Ltd.) made of a polyester fiber having a fiber diameter of 12.5 μm and a fiber length of 5 mm was impregnated with the following varnish, and  
20 the mixture was dried at 170°C for 5 minutes, to give a prepreg.

The varnish was prepared by adding 20 parts by weight of a curing agent dicyandiamide and 0.1 wt part of an accelerator 2-ethyl-4-methylimidazole to 100 parts by weight of a bisphenol A epoxy resin and dissolving the mixture in 40 parts by weight  
25 of methylethylketone.

Twenty prepreps were piled between a pair of release films (polypropylene, thickness: 50 μm), and the pile was held between



a pair of mirror surface plates. It was molded via two cushion papers having a thickness of 10 mm in a hot press under high temperature and high pressure. The molding condition was 175°C and 400 kPa for 120 minutes. As a result, a laminated plate having a thickness 1.5 mm was obtained. The fiber content in the entire laminated plate was 50 wt%. The plate was cut into a circular form; the surface was roughened by #70 diamond whetstone; and then trenches are formed thereon, to give a polishing pad. Trenches of 2 mm in width and 0.6 mm in depth were formed in a grid pattern with a pitch of 15 mm.

[0032]

#### Example 2

A laminated plate of 1.5 mm in thickness was prepared in a similar manner to Example 1, except that ten prepregs shown in Example 1 and ten non-resin-impregnated polyester nonwoven fabrics were laminated alternately. The fiber content in the entire laminated plate was 70 wt%. Then, the surface was roughened and trenches are formed in a similar manner to Example 1, to give a polishing pad.

[0033]

#### Example 3

A polishing pad was prepared in a similar manner to Example 1, except that a polyester woven fabric having a basis weight of 130 g/m<sup>2</sup> ("BKE poplin", manufactured by Asahi Kasei Corp., fiber diameter: 9 μm) was used as the fiber. In this Example, the fiber content in the entire laminated plate was 50 wt%.

[0034]

## Example 4

An organic fiber, polyester fiber having a diameter of 12.5  $\mu\text{m}$  and a length of 3 mm (manufactured by Japan Vilene Co., Ltd.), and a matrix resin, ABS resin pellet, were melt blended in an extrusion molding machine and tabletized. The fiber content therein was adjusted to 10 wt%. The tablet was dried in a large-sized dryer at 120°C for 5 hours, and was converted by using an extrusion molding machine and a roll into a sheet-shaped molding having a thickness of 1.2 mm and a width of 1 m. Trenches having a rectangular disk cross section of 0.6 mm in depth and 2.0 mm in width were formed thereon in a grid pattern with a pitch of 15 mm, and the molding was cut into a circular plate. Then, a double-sided adhesive tape was adhered to the face opposite to the face whereon the trenches are formed, and then, the surface was roughened by using #70 diamond whetstone, to give a polishing pad.

[0035]

## Comparative Example 1

A polishing pad was prepared in a similar manner to Example 1, except that a nonwoven fabric having a basis weight of 70  $\text{g/m}^2$  was prepared by spraying an aqueous 20 wt% solution of a water-soluble epoxy resin binder (trade name: "V Coat", manufactured by Dainippon Ink and Chemicals, Inc.) on a blend of a chopped para-aramide fiber ("Technola", manufactured by Teijin Ltd., fiber diameter: 12.5  $\mu\text{m}$ , fiber length: 5 mm) and a chopped meta-aramide fiber ("Conex", manufactured by Teijin Ltd., fiber diameter: 25  $\mu\text{m}$ , fiber length: 6 mm) and drying the

mixture at 150°C for 3 minutes under heat, and the nonwoven fabric was heat-compressed between heat rolls at 300°C, under an applied linear pressure of 196 kN/m. In addition, the surface was roughened by using #150 diamond whetstone. In the Comparative Example, the fiber content in the entire laminated plate was 50 wt%.

[0036]

#### Comparative Example 2

An ABS (acrylonitrile-butadiene rubber-styrene copolymer) plate having a thickness of 1.5 mm was cut into a circular form, and trenches of 2 mm in width and 0.6 mm in depth were formed on the surface in a grid pattern with a pitch of 15 mm. Then, the surface was roughened by using #70 diamond whetstone.

15 [0037]

#### Comparative Example 3

A polishing pad was prepared in a similar manner to Example 4, except that the surface was roughened by using #70 diamond whetstone.

20 [0038]

(Observation of surface)

The pad surface at any five points was observed under an SEM (scanning electron microscope) at magnifications of 100 and 200 times, and the maximum length of exposed fiber was determined.

25 [0039]

(Polishing slurry)

A CMP slurry was prepared as the polishing slurry by the

following method: Two kg of cerium carbonate hydrate was placed in a platinum container and sintered at 800°C for 2 hours in air, and 1 kg of the cerium oxide powder thus obtained was pulverized in a jet mill while it is dry. Twenty three grams of an aqueous ammonium polyacrylate salt solution (40 wt%) and 8,977 g of deionized water were added thereto, and the mixture was ultrasonicated for 10 minutes while agitated. The slurry obtained was filtered through a 1-micron filter, and deionized water was added thereto, to give a 5 wt% slurry. The pH of the slurry was 8.3. After dilution to a suitable concentration, the slurry particles were analyzed by using a laser diffraction particle size distribution analyzer, and as a result, D99% of particle diameter was 0.99  $\mu\text{m}$ .

[0040]

(Evaluation of polishing method and polishing characteristics)

Prepared were a blanket wafer having a silicon oxide film of 2  $\mu\text{m}$  in thickness formed on a  $\phi 127$  mm silicon wafer by the TEOS-plasma CVD method, and a test wafer carrying trenches having a square convex portion formed on a  $\phi 200$  mm Si substrate and additionally a  $\text{Si}_3\text{N}_4$  film and a silicon oxide film having a thickness of 600  $\mu\text{m}$  formed by the TEOS-plasma CVD method thereon. The region where the trench had a depth of 0.35  $\mu\text{m}$ , the density of the convex portion was 60%, and the trench width is 500  $\mu\text{m}$  was used.

[0041]

The wafer was connected to the holder with an adhesive

pad for attaching wafer in the polishing machine; the holder was placed on the  $\phi 380$  mm polishing table connected to the polishing pad prepared with its insulation film side facing downward; and the processing load was set to 29 kPa ( $300 \text{ gf/cm}^2$ ).

- 5 The insulation film was polished by rotating the polishing table and the wafer at 38 rpm for 2 minutes while supplying the cerium oxide polishing slurry at a rate of 150 cc/min dropwise on the polishing table. The wafer after polishing was washed thoroughly with purified water and then dried. The difference  
10 between the film thicknesses before and after polishing was measured by using a light-interference film thickness analyzer, and the polishing speed calculated. As for polishing scratch, the wafer surface after polishing was observed in dark field under a microscope and the number of the scratches remaining  
15 on the wafer surface due to polishing was counted.

Alternatively as for evaluation of flatness, the wafer was polished to a depth equivalent to the difference,  $1 \mu\text{m}$ , in the levels of the convex portion and concave portion on TEG wafer, and the final difference in level before exposure of the  
20  $\text{Si}_3\text{N}_4$  film of the convex portion was determined. The dishing in the trench area on the TEG wafer was determined by using a stylus profilometer.

[0042]

- Table 1 shows the polishing characteristics obtained in  
25 the Examples, and Comparative Examples. In Examples 1, 2, 3 and 4 where the polishing pad contains the polyester fiber according to the invention was used, it is possible to reduce

- the length of the exposed fiber easily and the polishing surfaces are superior in flatness and have fewer polishing scratches, compared to the polishing pad in Comparative Example 1 wherein the pad contains a high-rigidity aramide fiber. In addition,
- 5 as apparent from comparison between Examples 1, 2, 3 and 4 and Comparative Example 2 containing no fiber, the polishing speed was improved, and the polishing scratches were fewer as well.

[0043]

[Table 1]

Test number	Maximum exposure fiber length ( $\mu\text{m}$ )	Polishing speed (nm/min)	Number of scratch (number/wafer)
Example 1	10	210	0
Example 2	10	240	0
Example 3	10	240	0
Example 4	10	220	10
Comparative Example 1	50	190	40
Comparative Example 2	0	10	250
Comparative Example 3	150	350	10
	Flatness (nm)	Dishing (nm)	
Example 1	20	25	
Example 2	20	28	

Example 3	20	29
Example 4	30	25
Comparative Example 1	20	40
Comparative Example 2	No measurement possible	No measurement possible
Comparative Example 2	50	50

[0044]

[Effect of the Invention]

It is possible, by using the polishing pad characterized in that the maximum exposure fiber length is 0.1 mm or less, to improve the flatness and dishing resistance of the trench regions without generation of polishing scratches, and thus, to perform semiconductor production process such as flattening of interlayer insulation film and BPSG film and formation of shallow trench separation more efficiently.

[Name of Document]          Abstract

[Abstract]

[Object]      The present invention provides a polishing pad that allows efficient flattening and metal wiring , and suppression of the scratches on polishing surface in the CMP technology used for flattening of interlayer insulating film, BPSG film, insulation film for shallow trench isolation and forming of metal wiring and the like in the semiconductor element-manufacturing process. [Solving Means]      A method of producing a polishing

pad containing a fiber mainly of a polyester fiber exposed on the polishing surface and the maximum exposure length of the fiber is 0.1 mm or less; the method of producing a polishing pad comprising a step of mixing an organic fiber with a resin, 5 a step of tabletizing or pelletizing the mixture of the organic fiber and the resin, and a step of molding the tablets or pellets into plate shape by extrusion molding or injection molding; and a method of producing a polishing pad comprising a step of preparing a resin-impregnated sheet-shaped fiber base material 10 containing a polyester fiber mainly as the fiber, and a step of laminating the sheets of the sheet-shaped fiber base material by molding under heat and pressure.

[Selected Figure] None